Source Control Evaluation Addendum
Operable Unit 2
Swan Island Upland Facility
Portland, Oregon

Prepared for:
Port of Portland

December 27, 2011
1115-05

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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Table of Contents

Figures

Appendices

1.0 Introduction

1.1 Purpose

This report presents an addendum to the Source Control Evaluation (SCE) for operable unit (OU) 2 of the Swan Island Upland Facility (SIUF) located at 5225 N Channel Avenue in Portland, Oregon. Figure 1 shows the location of the SIUF, and Figure 2 shows the boundaries of OU2. The SCE (Ash Creek Associates, Inc. [Ash Creek], 2010) was performed in response to a request by the Oregon Department of Environmental Quality (DEQ) to identify, evaluate, and control sources of contamination that may reach the Willamette River consistent with the DEQ-EPA Portland Harbor Joint Source Control Strategy (DEQ, 2005). The DEQ provided comments on the SCE in a letter dated August 9, 2010, and the Port of Portland (Port) prepared responses to those comments in a letter dated September 22, 2010.

The Port is performing a Remedial Investigation/Feasibility Study (RI/FS) for the SIUF. The SIUF was previously referred to as the Swan Island Portland Ship Yard and identified by the DEQ as Environmental Cleanup Site Information (ECSI) site 271. The RI is being performed in accordance with the November 2, 2000 RI/FS Work Plan for the Portland Shipyard (RI/FS Work Plan; Bridgewater Group, 2000).

1.2 Scope of Work

This SCE addendum presents information and further evaluation requested in DEQ comments on the SCE. In addition to surface soil sampling requested by DEQ, the Port conducted additional riverbank soil sampling near a historical substation and in areas of visible erosion identified during site reconnaissance. The additional surface soil data were collected in accordance with DEQ-approved Work Plans. Results of the surface soil sampling were presented in separate letter reports (Ash Creek 2011a and 2011b). This SCE addendum should be used in conjunction with the SCE. Background information including regulatory framework, site description, and prior investigations are presented in the SCE (Ash Creek, 2010).

1.3 Addendum Organization

This addendum has two additional sections. Section 2 provides an updated evaluation of soil data incorporating data collected since completion of the SCE. Data are summarized in Appendices A and B. Section 3 presents a detailed evaluation of the potential for riverbank erosion. This section is accompanied by three appendices (Appendices C, D, and E) presenting supporting information.

2.0 Additional Upland Data Screening

In response to DEQ comments on the SCE and information obtained from further historical research and site reconnaissance, the Port collected additional soil samples as follows.

- Samples were collected from around the upland catch basin (that discharges to Outfall WR-163) to obtain surface soil data for butyl tins.
- Historical information indicated that the location of former Substation A was on a platform over the riverbank. Prior sampling was not conducted in that area, so additional surface soil sampling was conducted beneath and around former Substation A and samples were analyzed for polychlorinated biphenyls (PCBs).
- During a reconnaissance of the riverbank, areas of erosion were observed. Representative samples were collected from these areas and analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), PCBs, and butyl tins.

The results of the additional surface soil/riverbank sampling at OU2 are presented in letter reports (Ash Creek, 2011a and 2011b). Summaries of the analytical results are presented in Appendices A and B. Figure 3 presents the locations of soil samples. This section discusses screening of the additional soil data consistent with the screening conducted in the SCE.

2.1 Storm Water Pathway

The only potentially complete storm water pathway is erosion of upland surface soils located near the one catch basin that discharges to outfall WR-163. DEQ Joint Source Control Strategy (JSCS) guidance recommends that soil samples within an approximately 100-foot radius of a catch basin be screened against soil/storm water sediment SLVs. This is a reasonably conservative distance for the catch basin at OU2, given that the land surface around the catch basin is covered with compacted gravel, rather than asphalt pavement, and the catch basin collects runoff from a localized area where water tends to pond.

Soil samples were collected from around the upland catch basin to obtain additional surface soil data for butyl tins (Ash Creek, 2011a). The surface soil samples collected within the 100-foot radius of the catch basin are Daimler Lot-A1, Daimler Lot-A2, Daimler Lot-A3, and Daimler Lot-A4 collected between 0 and 6 inches below the ground surface (bgs). Prior to placement of samples into the sample container, soil was passed through a No. 4 sieve to remove gravel-size particles. The material that passed through the sieve was estimated to be approximately 30 percent by volume of the total collected sample. The samples were combined into a single composite sample. In addition, each of the subsamples was retained for chemical analysis. Analytical results are presented in Appendix A (Table 2 – Soil Analytical Results: Daimler Parking Lot Catch Basin).

Tributyltin (TBT), dibutyltin, and butyltin were detected in the composite sample. There are no JSCS soil/storm water sediment screening level values (SLVs) for dibutyltin and butyltin. TBT was detected at 25 times the JSCS SLV. Individual subsamples were analyzed for TBT, with results ranging from less than the detection limit to 640 micrograms per kilogram (µg/kg). Although TBT was detected above the SLV, the potential for contribution to the catch basin is limited because the surface is covered with compacted gravel and the material containing TBT is within the gravel matrix. Furthermore, as summarized below, based on evaluation of TBT in the draft final baseline ecological risk assessment (BERA; Windward Environmental, 2011) prepared for the Portland Harbor Remedial Investigation, TBT is unlikely to result in unacceptable risks at the concentrations detected near the catch basin.

TBT was evaluated in the BERA for a range of potential ecological endpoints and identified as a chemical of potential concern (COPC) for two main endpoints: fish diet and benthic toxicity. These are further assessed below.

- Fish Diet. For fish diet, the sediment Preliminary Remediation Goals (PRGs) for TBT presented in the April 21, 2010 memorandum from EPA (EPA, 2010) are 5.9 and 3.8 milligrams per kilogram (mg/kg) organic carbon (OC; smallmouth bass and sculpin, respectively). As discussed in a subsequent memorandum to EPA (Windward Environmental, 2010), these original PRGs were calculated using a toxicity reference value (TRV) based on a single study of dietary TBT toxicity to fish. Although that study had significant uncertainty, it was used for lack of better information. Since publication of the draft BERA, further review of the literature identified four additional studies containing fish TRVs for TBT. These additional studies were evaluated and a revised fish dietary TRV for TBT was recommended. The recommended revised TRV is 0.15 mg/kg body weight per day versus the originally used value of 0.002 mg/kg body weight per day (see lowest-observed-adverse-effect level [LOAEL] in first two rows of Table 1 in Windward Environmental, 2010). Using the revised TRV, the corresponding sediment PRGs for fish diet would be 440 and 280 mg/kg OC. Furthermore, assuming an average OC content for Portland Harbor sediment of one percent, the equivalent whole sediment PRGs would be 4,400 and 2,800 µg/kg (smallmouth bass and sculpin, respectively).
- Benthic Toxicity. In Table 6-10 of the draft BERA, the benthic Level 2 Sediment Quality Value (L2 SQV) for TBT is listed as 3,080 µg/kg.

Based on the above, there are multiple lines of evidence that TBT is not a significant COPC for the SCE, summarized as follows.

- Given the recommended revision to the TBT fish TRV and benthic L2 SQV, TBT is not likely to be a substantive chemical of concern in the harbor sediments.
- As presented in the SCE (Ash Creek, 2010), the maximum detected concentration of TBT in sediments adjacent to OU2 was 19 µg/kg, demonstrating that TBT is not a contaminant of concern in the sediments adjacent to OU2.
- The maximum detected concentration of TBT near the catch basin was 640 µg/kg, more than four times below the lowest revised sediment PRG.

2.2 Riverbank Erosion Pathway

2.2.1 Potential Sources

The SCE identified metals, total petroleum hydrocarbons (TPH), PAHs, PCBs, and TBT in riverbank soils, and additional sampling of riverbank soil was conducted for this SCE addendum. Comprehensive historical reviews of activities were conducted for the RI at the Facility. These investigations were not able to directly link specific sources to chemicals detected in riverbank soils. Swan Island has a long history of industrial activity related to ship building and ship repair. Although most of the activities directly related to ship building/repair did not occur on OU2, the presence of TBT (a chemical historically used primarily in the ship build/repair industry) in the soils suggests a link between the ship building/repair activities and the chemicals in the river bank. Potential mechanisms for transport of chemicals to the riverbank include aerial deposition of dust, stormwater discharge, and direct deposit of waste materials.

However, for the SCE, the uncertainty in the source of the riverbank chemicals is not a significant data gap because it has been verified that there are no current/ongoing sources of these chemicals to the riverbank. Thus, the relevant issue with respect to the SCE is the potential for the chemicals that are present in the riverbank to be transported to the river (see Section 3 of this addendum for evaluation of transport).

2.2.2 Scope of Riverbank Sampling

Twenty-five soil samples (plus some follow-up analyses of discrete samples comprising composite samples) were collected from the riverbank. Seven samples (RB-1 through RB-7) were discussed in the SCE and results are included in Appendix B (Tables 1 through 4 – Riverbank Soil Analytical Results). Two phases of additional sampling were conducted on the riverbank and these are summarized below.

Two composite soil samples were collected from the former substation location (Sub A - 2011 (Comp A) and Sub A - 2011 (Comp B)). One four-point composite surface soil sample was collected below the platform beneath the area observed to have historically included the electrical equipment and a second four-point composite surface soil sample was collected on the riverbank downslope of the platform (above the ordinary line of high water [OLHW]). The samples were analyzed for TPH and PCBs. Sampling and analysis are discussed in detail in a letter report to the Port (Ash Creek, 2011a). Sample locations are shown on Figure 3. Analytical results are presented in Appendix A (Table 1 – Soil Analytical Results: Historical Substation A).

Sixteen soil samples were collected along the riverbank at locations where site reconnaissance identified visible erosion features (see discussion in Section 3.3). At each of eight locations, a sample was collected from the ground surface (top of the erosion feature) and from near the vertical center of the erosion feature (approximate maximum depth of 3 feet below the original ground surface). Samples were analyzed for metals, PAHs, and PCBs. Selected samples were analyzed for TBT. Sampling and analysis are discussed in detail in a letter report to the Port (Ash Creek, 2011b). Analytical results are presented in Appendix B (Tables 1 through 4 – Riverbank Soil Analytical Results).

2.2.3 Riverbank Sampling Results

Metals. Riverbank soil sample data for metals are presented in Table 1 in Appendix B. Arsenic, cadmium, copper, lead, and zinc were detected at least once above background and the soil/storm water sediment SLVs. Lead was most frequently detected above the SLV (18 of 23 samples). The other metals were detected above the SLV five times or fewer. Except for two sample locations (RB-9 and RB-10), metals enrichment ratios (ER; concentration divided by SLV) were five or less (RB-1 through RB-7 are composite samples; two of 12 subsamples analyzed for lead had ERs between 5 and 10). At RB-9a, lead was detected at an ER of 13. At RB-10b, copper and lead were detected at ERs of 11 and 26, respectively.

PAHs. Riverbank soil sample data for PAHs are presented in Table 2 in Appendix B. Anthracene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene were detected at least once above the soil/storm water sediment SLVs. Indeno(1,2,3-cd)pyrene was most frequently detected above the SLV (seven of 23 samples). The other PAHs were detected above the SLV four times or fewer. Except for one sample location (RB-10b), PAH ERs were four or less (RB-1 through RB-7 are composite samples; one of nine subsamples analyzed for PAHs had an ER for indeno(1,2,3-cd)pyrene of 7). At RB-10b, indeno(1,2,3-cd)pyrene was detected at an ER of 11.

Total PCBs. Riverbank soil sample data for PCBs are presented in Table 1 in Appendix A and Table 3 in Appendix B. Aroclor 1254 was detected in one of 25 samples and Aroclor 1260 was detected in 19 of 25 samples. Except for Aroclor 1260 in sample RB-10b, the detected Aroclor concentrations were less than respective SLVs. The Aroclor 1260 concentration in RB-10b had an ER of 3. The total PCB concentrations for each of the riverbank soil sampling locations where PCBs were detected exceeded the total PCB JSCS bioaccumulation SLV (at ERs of 20 to 1600). Except for sample locations RB-9 and RB-10, ERs for total PCBs ranged between 20 and 230 and there is no apparent pattern to the distribution of PCBs on the riverbank. The three highest relative detections of PCBs (ERs from 400 to 1600) were in samples from locations RB-9 and RB-10.

TBT. Riverbank soil sample data for butyltins are presented in Table 4 in Appendix B. TBT was detected above the soil/storm water sediment SLVs in eight of 11 samples. TBT ERs ranged from 1.1 to 100 (RB-4 through RB-7 are composite samples; five of nine subsamples analyzed for TBT had ERs between 3 and 250). There is no apparent pattern to the distribution of TBT on the riverbank. The maximum detected concentration of TBT in riverbank samples was 580 µg/kg (a subsample at RB-4), nearly five times below the lowest revised sediment PRG as discussed in Section 2.1.

Riverbank Erosion Pathway Chemical Summary. Riverbank soils contain arsenic, cadmium, copper, lead, zinc, anthracene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, PCBs, and TBT at concentrations above respective SLVs. Excluding the area at sample locations RB-9 and RB-10, there is no apparent pattern to the distribution of chemicals in riverbank soils. Chemicals detected in riverbank soils are summarized as follows:

- General OU2 Riverbank
  - Metals – Primarily lead; ERs range up to 5
  - PAHs – ERs range up to 4
  - PCBs – Primarily Aroclor 1260; total PCB ERs range up to 230
  - TBT – ERs based on the SLV range up to 100 (but are below the likely revised sediment PRG discussed in Section 2.1)
- Area of Samples RB-9 and RB-10
  - Metals – Copper ER up to 11; lead ER up to 26
  - PAHs – Indeno(1,2,3-cd)pyrene ER of 11 in one sample
  - PCBs – Aroclor 1260 ERs up to 3; total PCB ERs range up to 1600

3.0 Analysis of the Potential for Riverbank Erosion

This section presents a quantitative analysis of the potential for erosion of the OU2 riverbank. The analysis included the following elements:

- Using historical aerial photographs to document changes in the riverbank location;
- Evaluating the physical stability of the existing riverbank;
- Documenting the surface finish of the riverbank;
- Evaluating potential for surface soil erosion from runoff using an analytical erosion model; and
- Assessing potential for erosion of the bank from river action.

3.1 Evaluation of Aerial Photographs

Eight aerial photographs spanning the period from 1936 through 2008 were reviewed to evaluate changes in the location of the Swan Island riverbank at OU2. Copies of the aerial photographs are included in Appendix C. The procedure used is summarized as follows.

1. The top of bank at OU2 was identified and the best-fit straight line representing the top of bank was drawn as shown on the photographs in Appendix C.
2. Three landmarks were identified that are present on each aerial photograph. These landmarks are marked on each photograph in Appendix C and were:

a. Sta A – Intersection of North Curtis Avenue and North Holman Street.

b. Sta B – Intersection of North Vincent Avenue and North Lombard Street.

c. Sta C – Railroad tunnel entrance in Mocks Landing area.

3. The perpendicular distance from the top of bank line to each landmark was scaled from each photograph.

Table C-1 in Appendix C presents the results of measurements. The table presents the photograph measurements, conversion to actual distances, and an estimate of the potential error based on identifying and measuring points on the photographs. The minimum, maximum, and mean distance determined from the photographs for the 72-year period are identified for each station. In each case, the minimum and maximum distances are contained within the range defined by the mean plus/minus the estimated error. These results demonstrate that there has been no discernible change in the location of the top of bank at OU2 during the period from 1936 to 2008.

3.2 Slope Stability Evaluation

3.2.1 Geotechnical Conditions

In developing data for use in the slope stability analyses, we reviewed the contents of over 40 geotechnical reports prepared for past projects within the general project area. These reports were provided by the Port from their archives. Seven of the reports contained subsurface information within the immediate project vicinity, listed as follows:

- Dames and Moore, Foundation Investigation, Proposed General Cargo Berths, December, 1964
- Dames and Moore, Soils and Foundation Studies, Repair Berths 311, 312, and 313, May, 1977
- Dames and Moore, Soils Investigation, Underwater Slope Failures, Swan Island Ship Repair Yard, May, 1978
- Geotechnical Resources, Inc., Interim Report, Module Fabrication Facilities, October, 1984
- Geotechnical Resources, Inc., Final Report for Subsurface Investigation, Module Fabrication Facilities, May, 1985
- Geotechnical Resources, Inc., Geotechnical Investigation, Module Fabrication and Load-Out Facility, July, 1985
- VanDehey Soil Explorations, Dutch Cone Probes for Lampson Crane Stability Analysis, Berth 313, September, 1986

The subsurface data available in these reports were screened for applicability to the project relative to proximity and exploration methodology. A total of 40 borings and 16 cone penetrometer tests (CPTs) were included in this review. The most significant data available from the borings consisted of standard penetration test (SPT) blow counts. The SPT test results were summarized and corrected for rod length, overburden pressure, and hammer efficiency. For corrections, mid-range values as recommended by the Federal Highway Administration (FHWA) were used.

The following soil units were encountered in the explorations reviewed.

Loose to Medium Dense Sand Fill. The upland areas within the project site were constructed of medium dense dredge sand fills. The dredge fills extend from the ground surface (under surface improvements) to an approximate elevation of 15 feet.

Silt Sediments. The dredge sands are underlain by soft to medium stiff silts with varying sand content. These soils represent the depositional material placed within a moderate energy environment and are typical of sediments encountered in the Mocks Landing and Guilds Lake areas of Portland. The silt sediments extend to an approximate elevation of 0 feet.

Medium Dense Sand. The silt sediments are underlain by medium dense to dense, medium to coarse sand. This sand is consistent with Willamette River alluvium. Based on past laboratory testing, the fines content of this sand ranges from 3 to 8 percent.

3.2.2 Methods of Stability Analysis

Three cross sections through the existing riverfront slope were developed and analyzed for global stability. Upland topography was generated from survey data prepared for the Port in 2001 by Olson Engineering, Inc. Bathymetry was developed based on information available in Lower Willamette Group documents as well as past geotechnical studies for the area. The location of rip-rap and the condition of the existing bank was observed by Ash Creek Staff during a field reconnaissance effort. The cross sections developed were also compared against similar sections developed by past geotechnical consultants. Based on these data, the existing slopes are generally at 3:1 horizontal: vertical.

Stability modeling was conducted with GeoSlope's software package SLOPE/W. The software employs a limit equilibrium methodology for calculating a factor of safety against sliding or sloughing. The analysis was completed using Spencer's method which satisfies both moment and force equilibrium. For each section, we evaluated the slope stability safety factor based on a random search of circular, block, and segmental slip planes.

Soil parameters used in the analyses were developed based on the results of the geotechnical review. SPT blow counts, CPT cone pressure values, laboratory strength testing, and gradation data were used in concert with published references to develop strengths and unit weights.

3.2.3 Results

The minimum factor of safety developed from our stability analysis was 1.7. A factor of safety in excess of 1.5 is broadly considered stable. The results of our stability analysis indicate that the slopes will be stable under normal operating conditions.

3.3 Riverbank Reconnaissance

On October 6 and 7, 2010, Ash Creek completed a visual reconnaissance of the OU2 riverbank. The entire length of the bank was observed, mapped, and photographed. Figure 3 shows the results of the visual mapping, identifying geomorphic features, vegetation, and structures. Photographs documenting the observations are included in Appendix D.

In general, the surface condition of the riverbank is characterized by dense vegetation above the approximate OLHW (identified based on visual determination of the location where predominantly upland vegetation was present). Vegetation generally consists of grasses and shrubs. Photographs 1 through 4 show typical examples of the vegetation on the riverbank.

Below the OLHW, the bank generally consists of rip rap with occasional sandy beaches. Photographs 5 and 6 show typical examples of these conditions.

Locally, various surface features (designated A through Q) were observed and mapped. The location and ground elevation of observed erosion features were surveyed by a licensed surveyor. The observed features are identified on Figure 3 and discussed below.

- A – Bare ground with dimensions of approximately 4 feet by 8 feet. See Photograph 7. This area is adjacent to a ship tie-down. There is evidence of prior attempts to landscape around the tie-down – plastic sheeting and bark mulch are evident in the photograph.
- B – Bare ground approximately 1 foot in diameter (Photograph 8).
- C – Outfall WR-399 (Photograph 9)
- D – Bare ground located below the OLHW with dimensions of approximately 80 feet long by 3 feet wide. See Photographs 10 and 11. This feature appears to be related to outfall WR-399 (note surface water in Photograph 11). The soil in the exposed surface differs from that observed elsewhere on the bank and in upland borings. Instead of primarily sand that is observed elsewhere, the soil at this location consists of clayey silt exhibiting some cohesiveness. Additionally, instead of rip rap below this area, the slope consists of a sandy beach (Photograph 12).
- E – Depression in riverbank (Photograph 13). This feature is approximately 30 feet wide and exhibits the characteristics of historical disturbance to the bank. This is the location of former

outfall CG-26 that was removed in October 2008 (Ash Creek, 2009a). This feature is covered with dense vegetation and shows no signs of current erosion. The slope below this area is characterized by a combination of rip rap and sandy beach (Photograph 13).

- F – Outfall CG-28 (Photograph 14).
- G – War-era shipyard substation A concrete platform (Photographs 15 and 16).
- H – Manway to breasting dolphin (Photograph 17).
- I – Erosion scarp (Photograph 18). This feature is located near the OLHW (toe elevation of 15.3 to 15.9 feet NGVD) with a length of 35 feet. The maximum height of the scarp is 1.5 feet, but for most of its length, the scarp is less than 6 inches high. This feature is below the approximate location of former outfall WR-160 that was removed in August 2006 (Ash Creek, 2007).
- J – Erosion scarp. The scarp appears to be located near the OLHW. The scarp length is 635 feet. The average height is 3.1 feet and the maximum height 6.6 feet (Photographs 19 and 20). The northern 375 feet of the scarp is located near the OLHW (toe elevation varies from 15.0 to 21.9 feet NGVD). The southern 260 feet of the scarp is above the OLHW (toe elevation varies from 18.4 to 20.0 NGVD). At one area, a second smaller scarp (length of about 30 feet) is present above the primary scarp.
- K – Aggregate conveyor (Photograph 21).
- L – Erosion scarp (Photograph 22). The scarp is above the OLHW (toe elevation of 19.5 to 20.8 feet NGVD), 56 feet long, and up to 3.0 feet high.
- M – Erosion scarp (Photograph 23). The scarp is above the OLHW (toe elevation of 20.3 to 21.8 feet NGVD), 53 feet long, and up to 2.7 feet high.
- N – Erosion scarp within depression in riverbank (Photograph 24). The scarp is above the OLHW (toe elevation of 21.1 to 22.9 feet NGVD), 49 feet long, and up to 2.0 feet high. The depressed riverbank is approximately 80 feet wide and exhibits the characteristics of historical disturbance to the bank. This feature is covered with dense vegetation and shows no signs of current erosion associated with the depression. The slope below this area is characterized by a combination of rip rap and sandy beach.
- O – Depression in riverbank (Photograph 25). This feature is approximately 50 feet wide and exhibits the characteristics of historical disturbance to the bank. This feature is covered with dense vegetation and shows no signs of current erosion.
- P – Erosion scarp (Photograph 26). The scarp is near the OLHW (toe elevation of 15.1 to 15.5 feet NGVD), 2.1 feet long, and up to 1.1 feet high.
- Q – Outfall 163 (Photograph 27).

In summary, the riverbank is characterized by dense vegetation with 17 observed surface features. Six of these features are structures (C, F, G, H, K, and Q). In addition, two features consist of historical bank disturbance (some associated with historical outfalls no longer present) but the surface is now densely vegetated and there was no evidence of current erosion (E and O). Two features (A and B) are bare ground high on the bank with a total surface area of approximately 30 square feet. One feature (D) consists of bare ground (total surface area of approximately 240 square feet) apparently associated with outfall WR-399. Finally, six features consist of visible erosion scarps (I, J, L, M, N, and P). The erosion scarps are discussed further below.

The erosion scarps are linear features running parallel to the riverbank. They are located at or above the transition from rip rap to vegetated riverbank. The total length of the scarps is 830 feet (or 30 percent of the total bank length). Of that total, approximately 300 feet of the scarps encroach below the OLHW (toe elevations ranging from 15.0 to 16.6 feet NGVD). As discussed in Sections 3.4 and 3.5, overland flow and river action are not likely causes of the observed erosion. Instead, the observed characteristics of the erosion are consistent with erosion resulting from wave action (caused primarily by boat wakes). The majority of the riverbank is covered with rip rap or dense vegetation and has no evidence of erosion, demonstrating that rip rap and vegetation are effective. It is likely that the erosion scarps originated in areas with a poor transition from rip rap to dense vegetation. For example, if the top elevation of the rip rap is below the OLHW in a particular location, upland vegetation at that transition may struggle to sustain dense growth from year to year. If, during a down year for vegetation, the river level is sustained at a level just above the rip rap, boat-wake action could initiate erosion that leads to a small vertical scarp. As long as the water level is above or below the location of the erosion scarp, no substantive erosion would occur. Whenever the water level is at the level of the scarp, however, the bank would be subject to additional erosion. Observations of the riverbank support this model. For example, at multiple locations, the vegetation has become well-established below the location of the erosion scarp (see Photographs 43 and 44). This indicates that at least one to two growing seasons passed without substantial erosion of the scarp.

The location of the largest erosion scarp (J) is roughly centered on the aggregate barge conveyor serving the Cemex facility. The Cemex facility began operation in 2007. The most recent prior reconnaissance of the riverbank was conducted in October 2005 in association with the ecological risk assessment for OU2. The erosion scarp at feature J observed in 2010 was not observed at the time of the 2005 reconnaissance, suggesting that the bulk of the erosion associated with that feature occurred after 2005. This further suggests that much of the erosion may be associated with the movement of barges in and out of the mooring location.

3.4 Analytical Erosion Model

Surface soil erosion was evaluated using the Revised Universal Soil Loss Equation developed by the United States Department of Agriculture – Natural Resources Conservation Service (NRCS). Software available from the NRCS was used to evaluate soil loss (RUSLE2). Input parameters include geographic location, soil type, slope length, slope steepness, and ground cover. The following were assumed for input parameters to simulate the OU2 riverbank.

- From the geotechnical assessment in Section 3.2.1, soil conditions consist of primarily sand to a depth of approximately 15 feet. Below that depth, soils generally consist of silt. Two different soil types were selected from the library of available soils to represent the range of potential soils generally encountered on the OU2 riverbank: loamy sand and sand.
- Slope steepness is 3H:1V (33%) as discussed above for the slope stability calculations.
- From Port surveys, the top of bank elevation was assumed to be 33.6 feet (17 feet above the OLHW), yielding a slope length of 54 feet from top of bank to the OLHW;
- From the visual reconnaissance, the surface cover consists of 99.8 percent dense vegetation and 0.2 percent of exposed soil. Two different ground covers were selected from the library of available groundcover to represent this range of surface cover: dense grass and smooth fresh cut soil.

Input/output pages from the RUSLE2 runs are included in Appendix E. The model predicts that the average annual erosion under current conditions is less than one one-thousandth of an inch (calculations included in Appendix E).

These results are supported by the bank reconnaissance discussed above. Surface erosion resulting from runoff would be characterized by rills running down the bank. These would be especially visible at the erosion scarps discussed above. No rills were observed on the riverbank.

3.5 Assessment of Potential for Erosion from River Action

Erosion from river action has two primary components: (1) bed shear resulting from the natural motion of the flowing water; and (2) wave action caused primarily from boat wakes.

Bed Shear. Bed shear was evaluated as part of the Portland Harbor RI. Figure E-1 presents bed shear estimates along Swan Island adapted from modeling conducted as part of the Portland Harbor RI/FS Comprehensive Round 2 Report. The OU2 riverbank is located near River Mile 9 on the river side of Swan Island. Under both the high flow and low flow scenarios, bed shear is negligible along the OU2 riverbank. These results indicate that erosion from natural river flow is unlikely regardless of the soil and surface cover conditions.

Wave Action. In general, waves impacting unprotected riverbank may cause significant soil erosion depending on such factors as soil type, slope steepness, and wave height. The riverbank below ordinary high water is generally covered with rip rap. The vast majority (greater than 99 percent) of the riverbank above ordinary high water is covered with dense grasses/vegetation. In both of these cases, the surface cover is sufficient to withstand erosion from wave action (this is supported by the bank survey described above). A portion of the riverbank, however, has a visible erosion scarp near and above the OLHW. In the absence of maintenance of these features, when the river level is near the elevation of the erosion scarp, wave action is likely sufficient to cause erosion of the scarp face.

3.6 Summary of Potential Riverbank Erosion

- Historical aerial photographs indicate that there has been no detectable change in the location of the top of the riverbank at OU2 since the island was constructed in the 1920s.
- Slope stability calculations of the OU2 riverbank indicate the existing slope has an acceptable factor of safety with respect to potential slope failure.
- Reconnaissance of the riverbank determined that the bank is generally covered with dense vegetation or rip rap. Erosion scarps were observed at six locations for a total length of 830 feet (compared to the length of the riverbank of 2,700 feet). The height of the erosion scarps varied from less than 1 foot up to 6.6 feet. The scarps appear to be the result of wave action from boat wakes.
- The potential for erosion of the riverbank from surface runoff was determined to be negligible.
- Except for the potential for additional erosion of the existing scarps from wave action (resulting from boat wakes), the potential for erosion of the riverbank from river action was determined to be negligible.

4.0 Findings and Conclusions

The SCE addendum presents an updated evaluation of soil data from riverbank soils. Riverbank soils contain arsenic, cadmium, copper, lead, zinc, anthracene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, PCBs, and TBT at concentrations above respective SLVs. For most of the riverbank, there is no apparent pattern to the distribution of chemicals, ERs for metals and PAHs are less than 5, and ERs for TBT and total PCBs range up to 100 and 200, respectively. In the area of samples RB-9 and RB-10, metals and PAHs are present at ERs in the range of 10 to 30 and total PCBs are present at ERs up to 1600.

The erosion evaluation presented in Section 3 indicates that erosion of the riverbank has occurred and that further erosion is possible. The past and potential future erosion is associated with wave action against unprotected (i.e., inadequate rip rap or vegetation) riverbank. Based on locations of observed erosion features, the potential for erosion occurs when the river level exceeds elevation 15 feet NGVD.

Based on the presence of metals, PAHs, TBT, and PCBs above SLVs in riverbank soil, and the potential for erosion of the riverbank, a source control alternatives evaluation is recommended.

5.0 References

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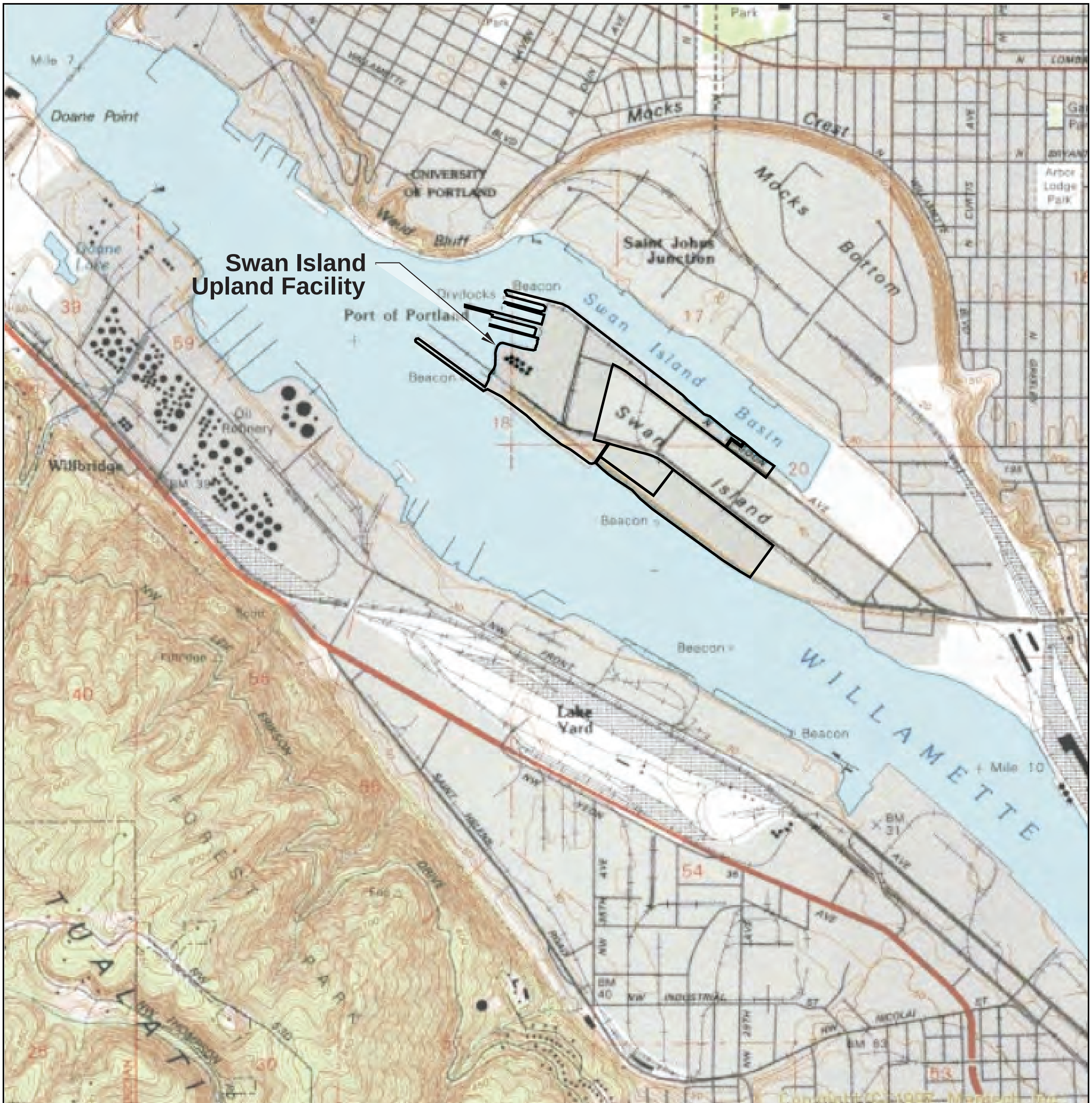
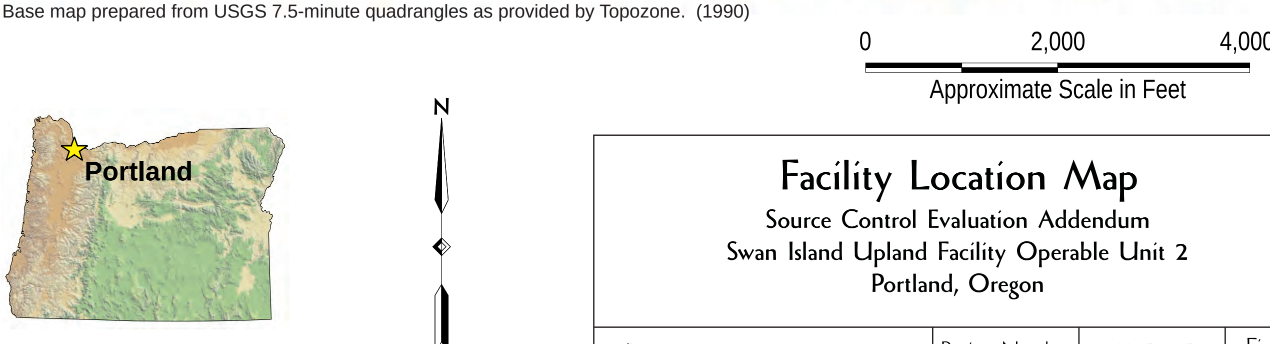


NOTE: Base map prepared from USGS 7.5-minute quadrangles as provided by Topozone. (1990)



Facility Location Map

Source Control Evaluation Addendum
Swan Island Upland Facility Operable Unit 2
Portland, Oregon

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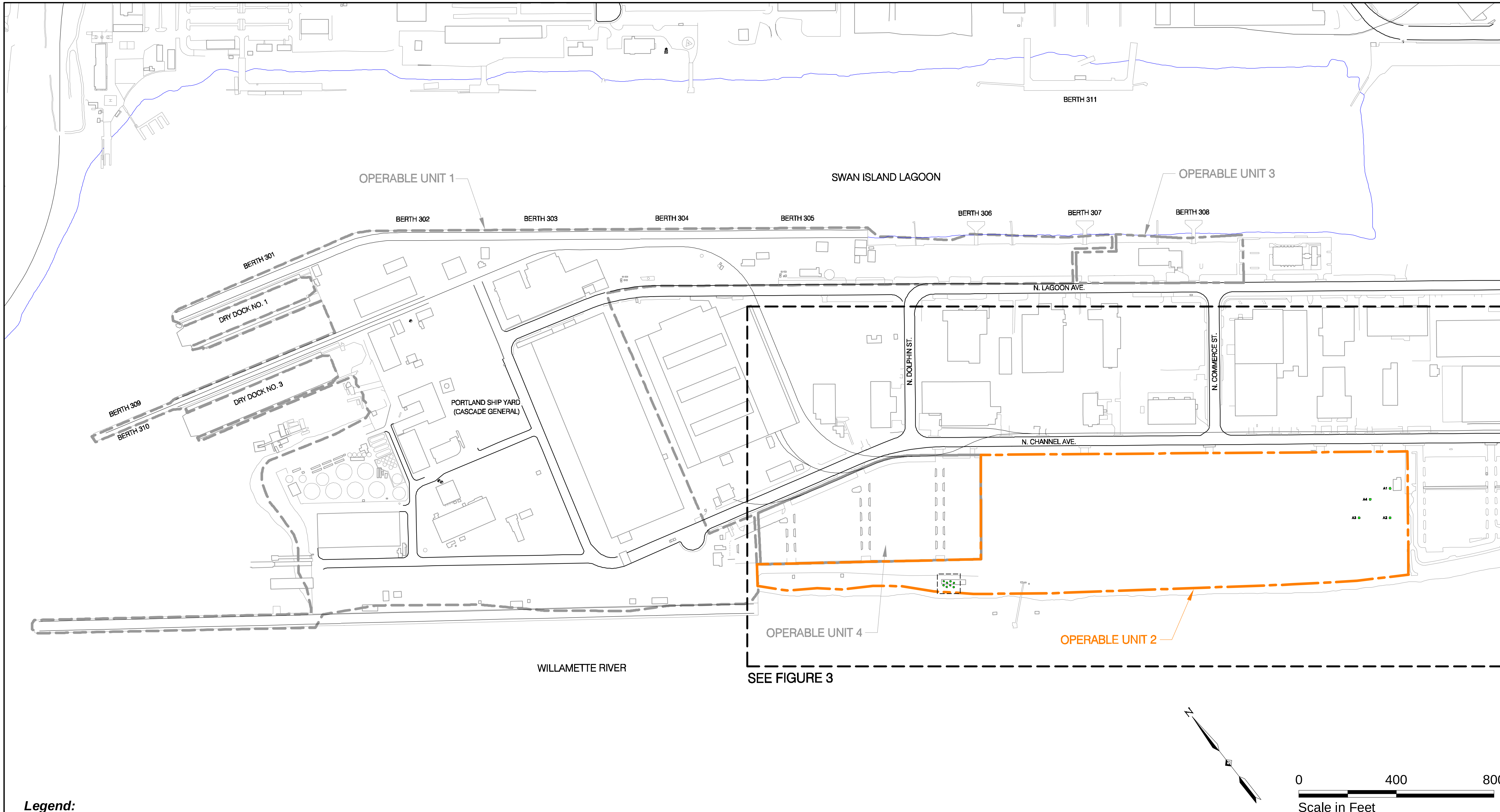
	December 2011		1



Legend:

- Operable Unit 1 Boundary
- Operable Unit 2 Boundary
- Operable Unit 3 Boundary
- Operable Unit 4 Boundary

NOTE:
1. Prepared from AutoCAD base map received from the Port of Portland in June 2007.

Site Vicinity Plan

Source Control Evaluation Addendum
Swan Island Upland Facility Operable Unit 2
Portland, Oregon

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Project Number	1115-05	Figure
December 2011		2

Legend:

- A1 Discrete Sample Location
- Catch Basin
- Stormwater Line and Flow Direction
- WR-399 Outfall Location and Designation
- WR-160 Storm Water Pipe Location and Designation (Abandoned July 2006)
- RB-8 Riverbank Soil Sampling Location (RB-8 through RB-15)
- RB-4 Historical Riverbank Sample Location (RB-1 through RB-7)

NOTES:

1. Prepared from AutoCAD base map received from the Port of Portland in June 2007.
2. Aerial photograph from 2010 - Google Imagery dated June 19, 2008.

Riverbank Reconnaissance and Soil Sampling Plan

Source Control Evaluation Addendum
Swan Island Upland Facility Operable Unit 2
Portland, Oregon

Ash Creek Associates, Inc.
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Project Number	1115-05	Figure
December 2011		3